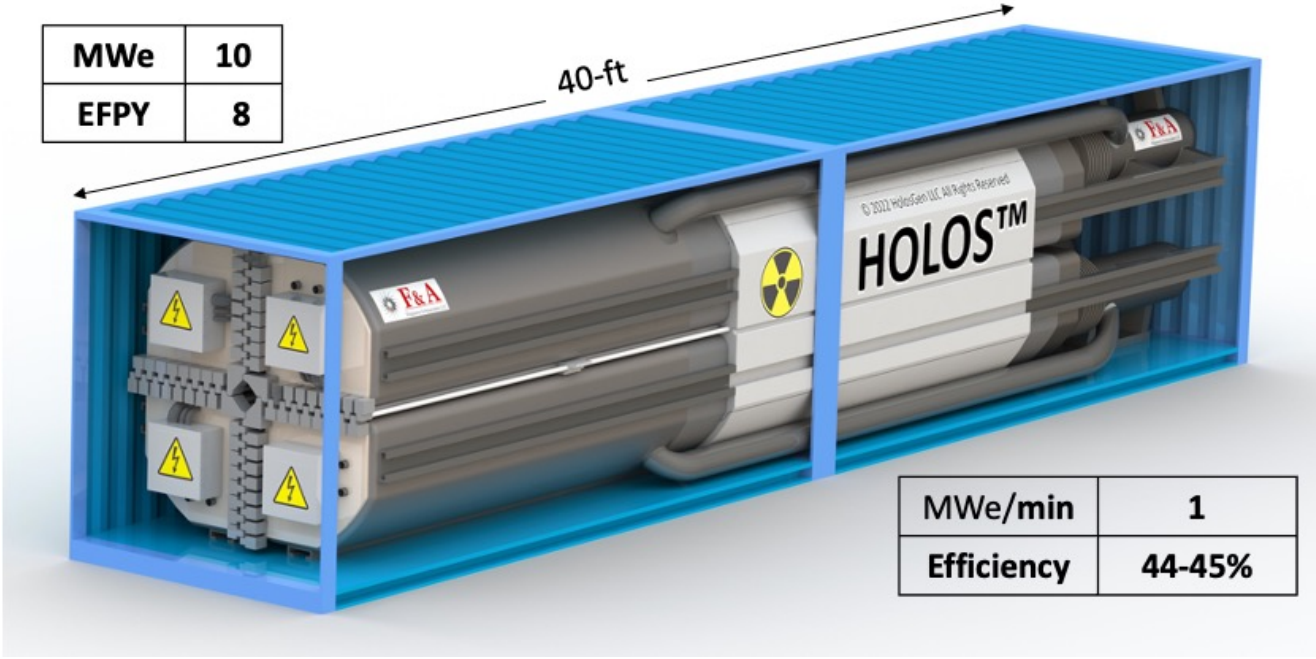
Transportable Modular Reactor by Balance of Plant Elimination

Dr. Claudio Filippone
HolosGen LLC

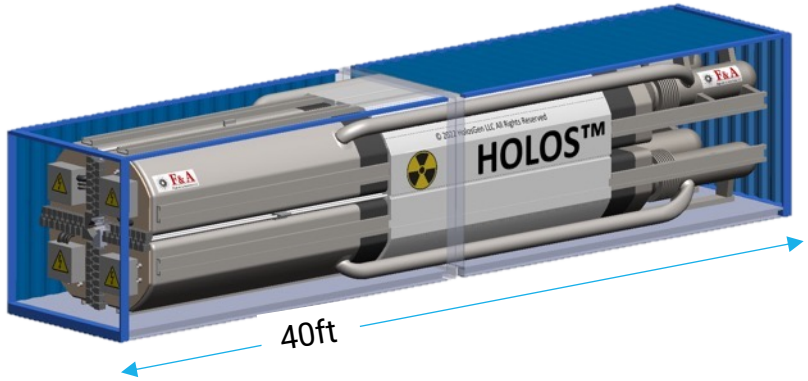
April 1, 2022



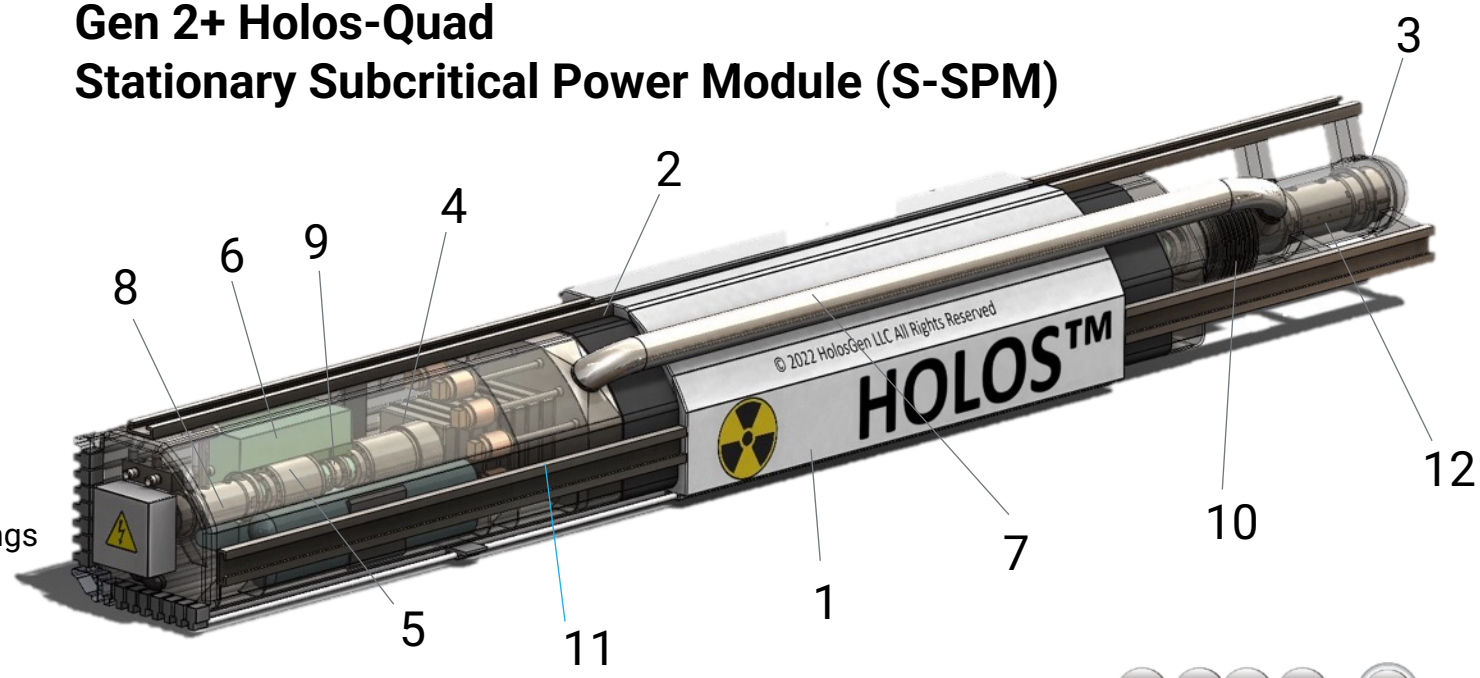
Techno-Economic-Safety Validation

2018 Objectives
Demonstrate costing and performance

- Demonstrate the feasibility of the “Holos-Quad” microreactor to deliver **10 MWe** at **45%** efficiency for **8 EFPY** fully comprised and transportable within a **40-foot** shipping container
- Enable competitiveness with non-nuclear electricity and process heat sources
- Validate the TEA and safety performance in collaboration with ANL and Academia



Gen 2+ Holos-Quad
Stationary Subcritical Power Module (S-SPM)



1. Fuel Cartridge
2. Cartridge Pressure Vessel
3. 3rd Containment Vessel
4. HP Compressor
5. Multi-stage Compressor
6. Intercooler HEX
7. Flow return
8. EM Motor
9. Active Magnetic Bearings
10. Power Turbine
11. Recuperator HEX
12. EM Generator

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2018-2022 Design Validation

HolosGen MEITNER Team

Advisory Board

Principal Investigator
Dr. Claudio Filippone

Internal PMO
- Safety
- Contract
- Quality
- Admin

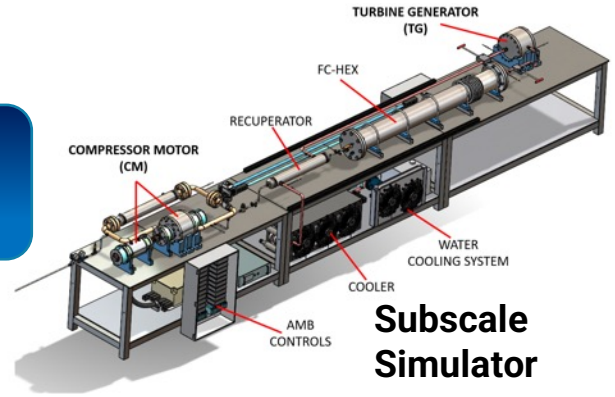
External PMO
PARSONS

Argonne NATIONAL LABORATORY
Design Team: Dr. Nicolas Stauff
Resource Team: Dr. Ling Zou

UNIVERSITY of VIRGINIA
PI: Dr. Roger Fittro

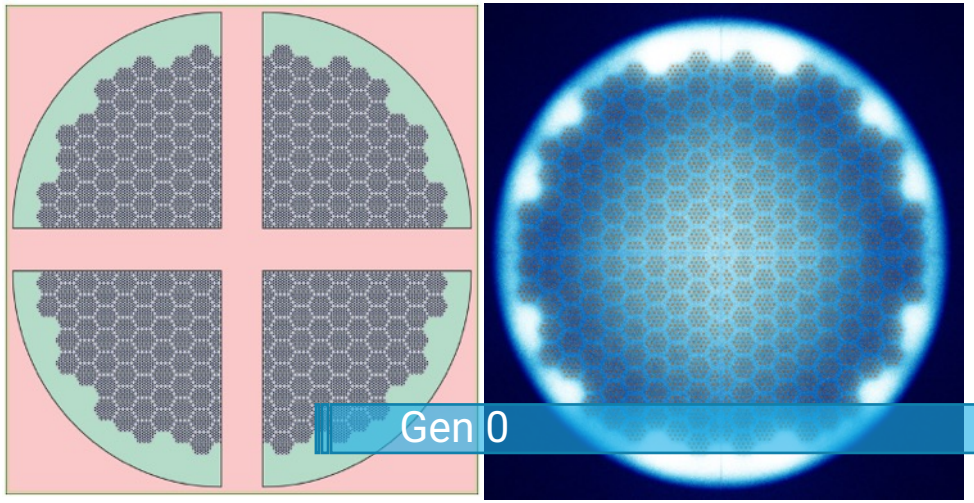
High-Fidelity Modeling & Specialized Inputs
ANL & Universities

Design, Integration, Manufacturing ,Assembly & Electrical Testing
Dr. Claudio Filippone
ME, EE, TE, MA

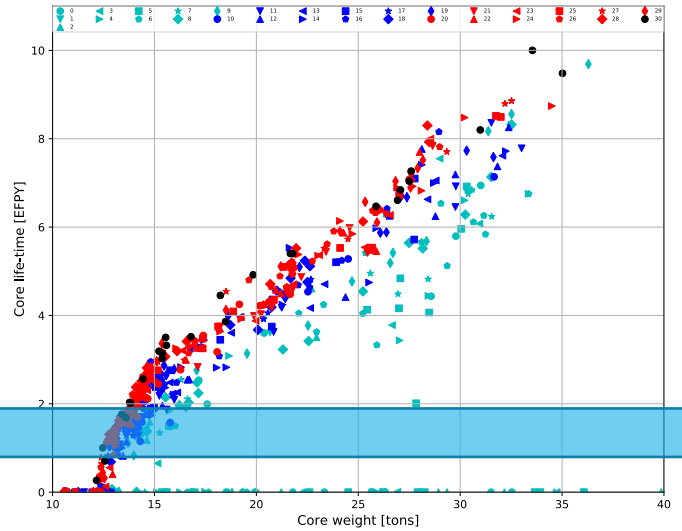


Subscale Simulator

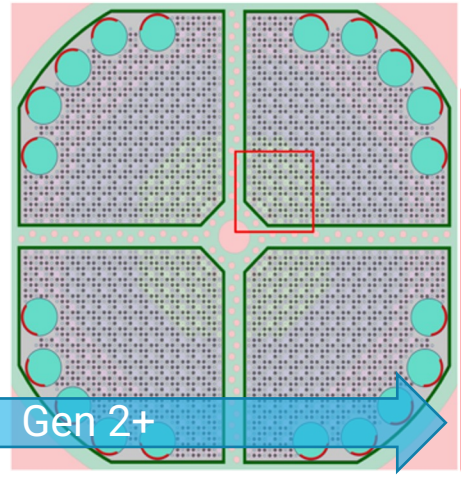
Mobile SPMs

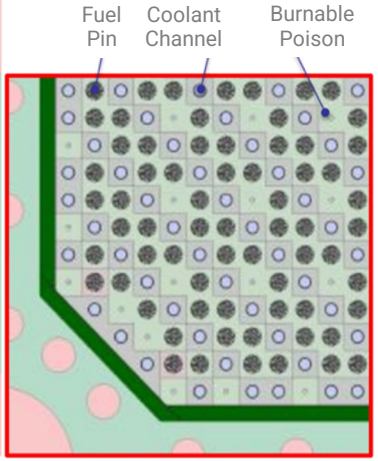


Multi-Objective Genetic Algorithm



Stationary SPMs





Gen 0 → Gen 2+

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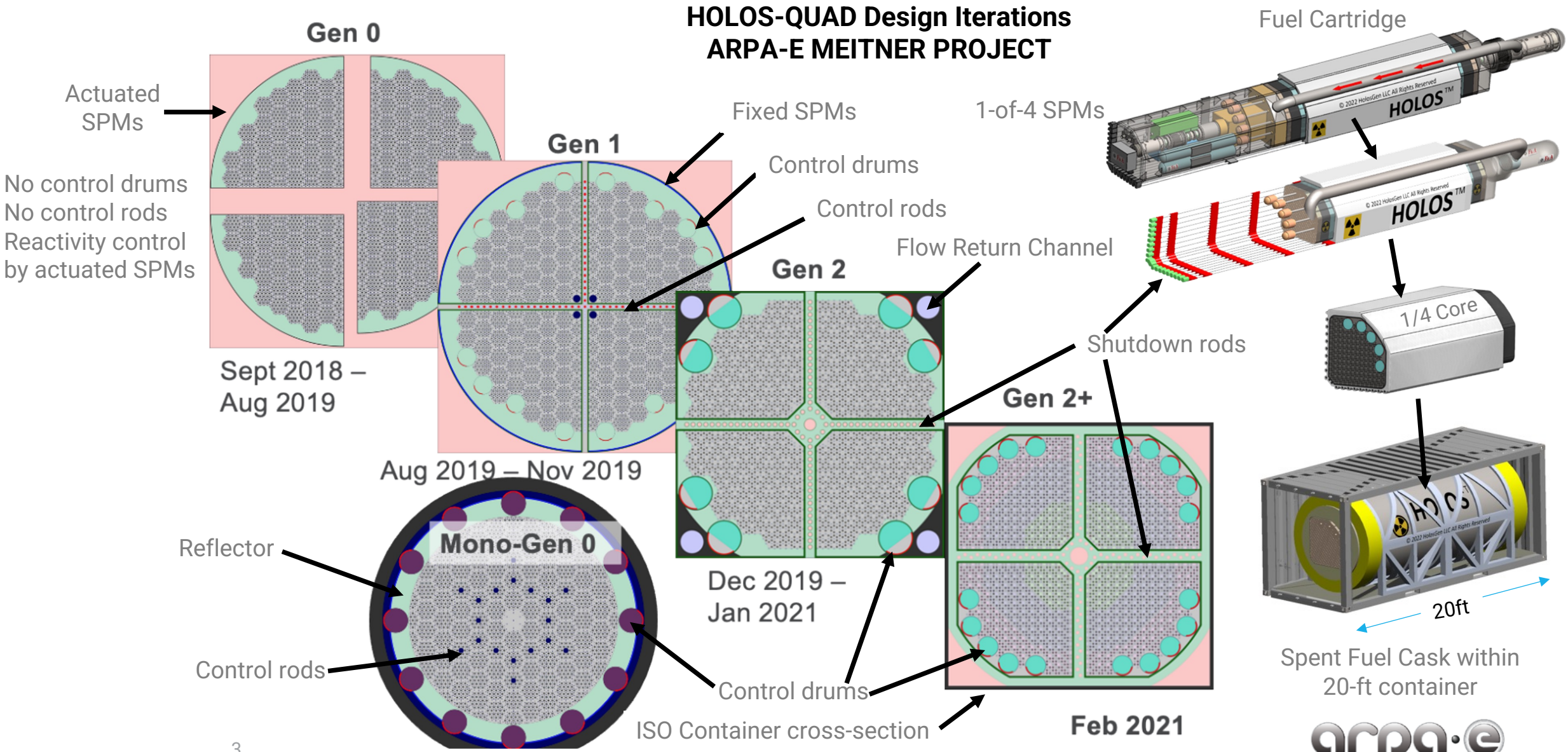
Holos-QUAD Neutronics Optimization

Accomplishments



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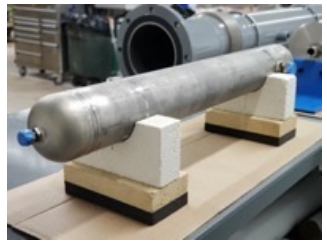
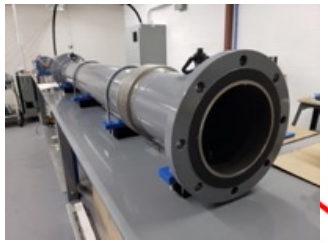
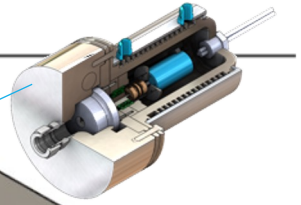
7MPa Helium Subscale Simulator

Testing Validation

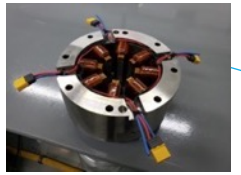


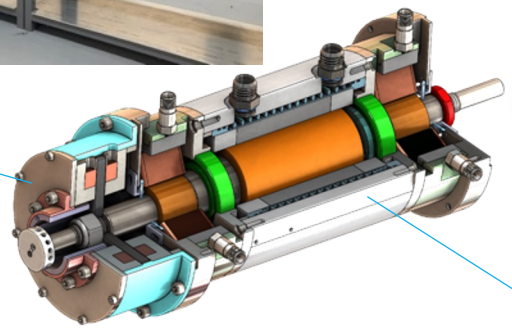




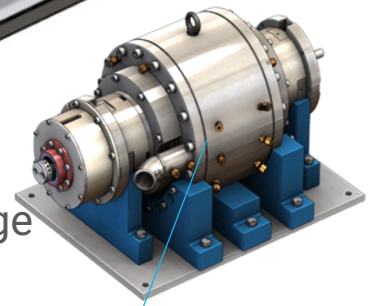
TURBINE GENERATOR
(TG)

RECUPERATOR





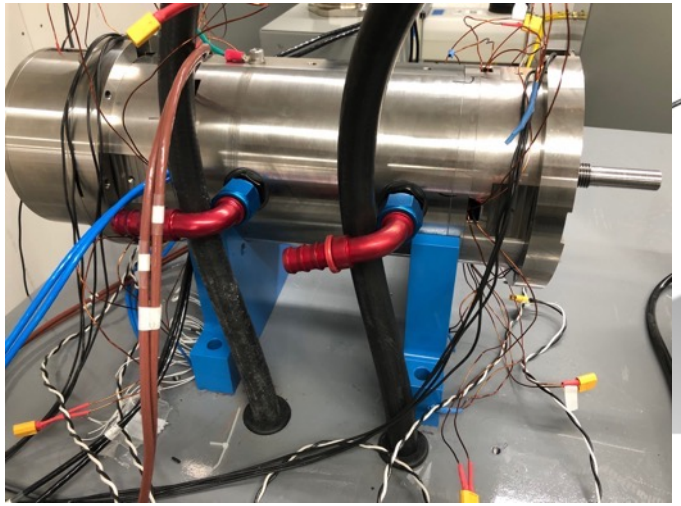
COMPRESSOR MOTOR
(CM)



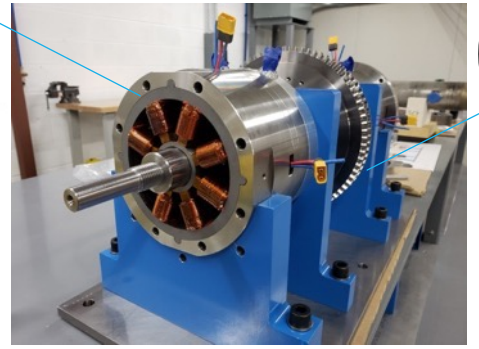
Surrogate
Fuel Cartridge

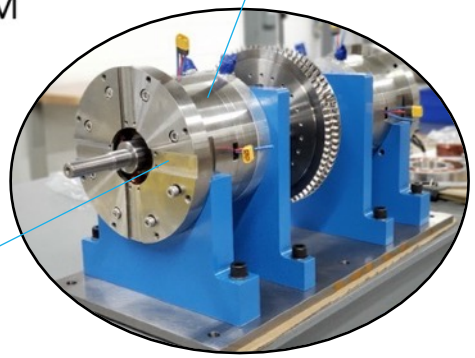
WATER
COOLING SYSTEM

COOLER



AMB
CONTROLS





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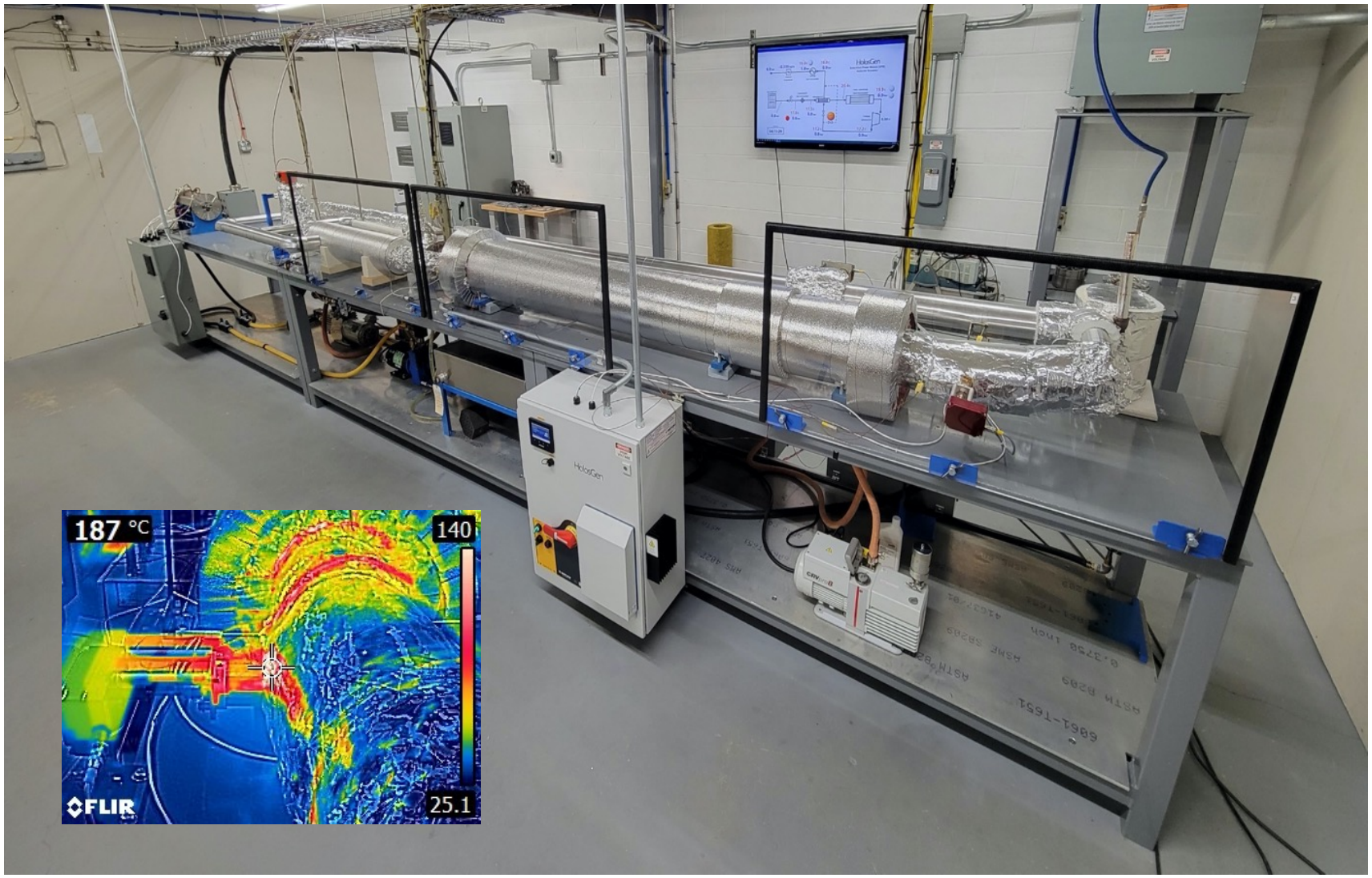
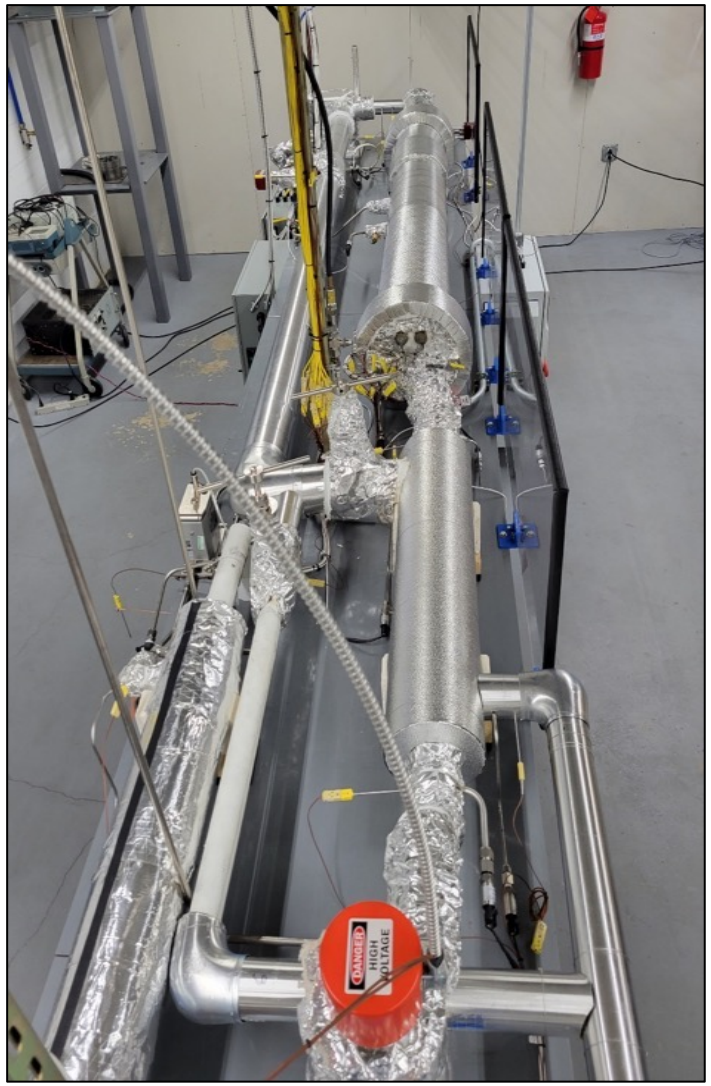
7MPa Helium Subscale Simulator

Operational 2021

LOCA & SBO Safety Tests





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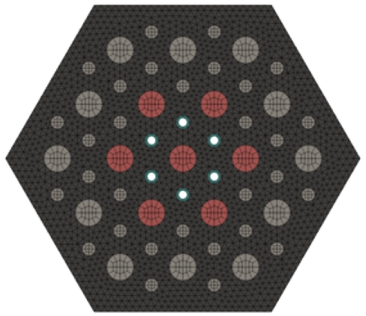
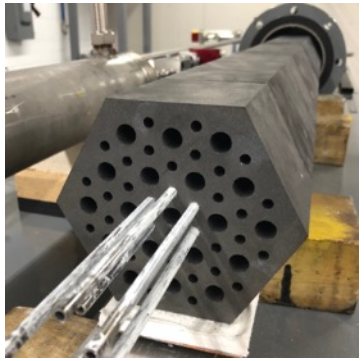
7MPa Helium Subscale Simulator

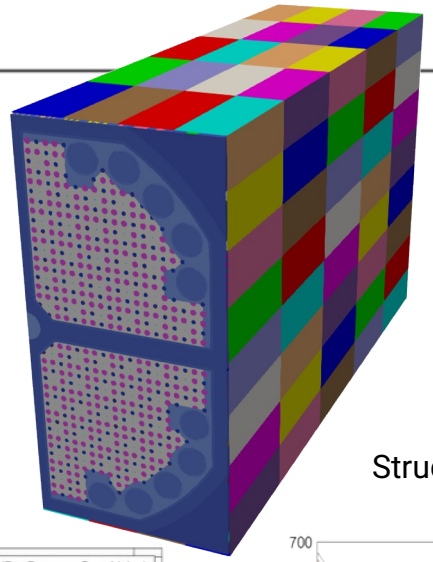
DBA LOCA & SBO Scenarios

Heat-Transfer & Thermal-hydraulics

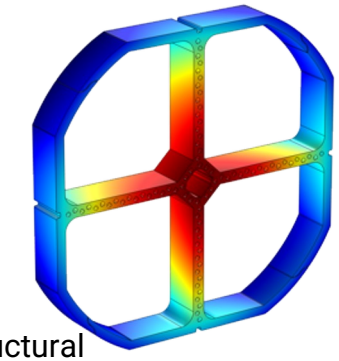
System Analysis Module (SAM)



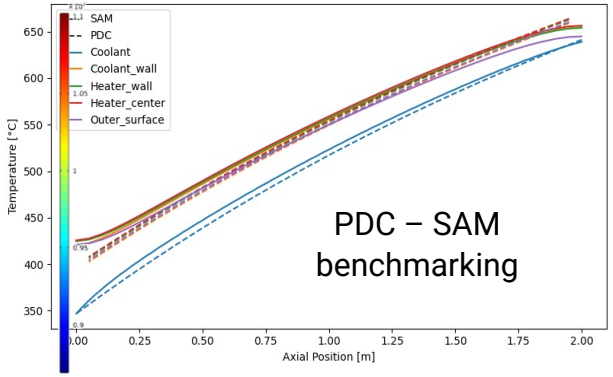


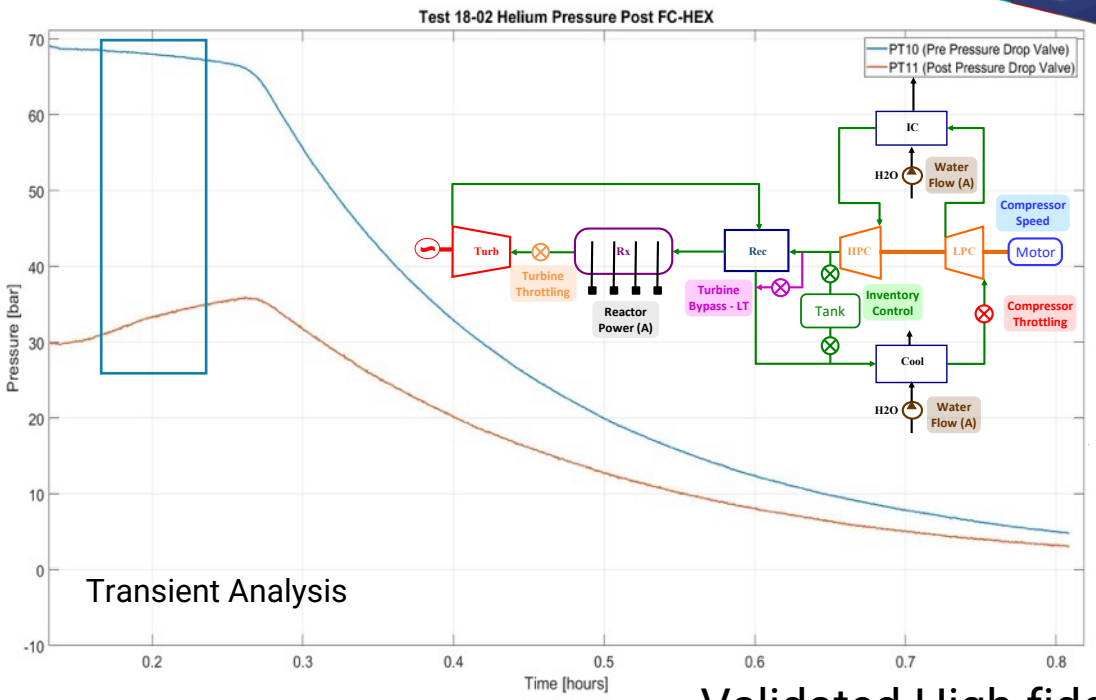


Passive decay heat removal

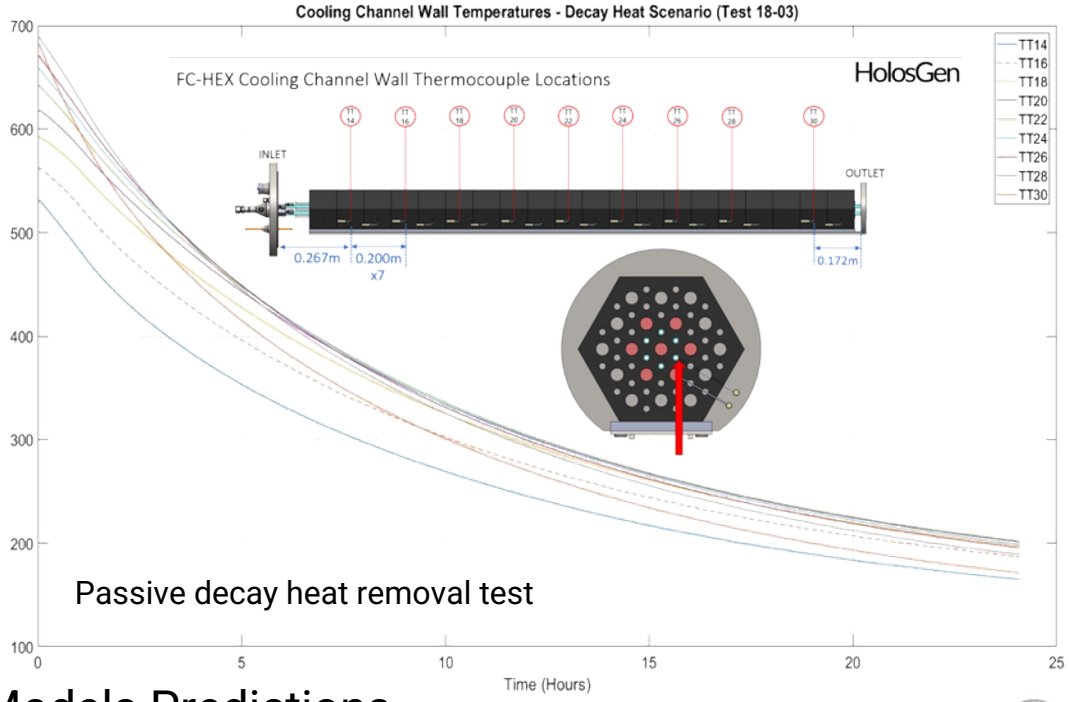


Structural





Transient Analysis



Passive decay heat removal test

Validated High-fidelity Models Predictions

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Substantiated Due Diligence

Technology-to-Market

- Multiple peer-reviewed scientific publications accessible by the general public
- Focus on TT&O activities, scheduled full-design presentations throughout 2022
- Ongoing due diligence activities with manufacturers, nuclear vendors and investors

1. Nicolas E. Stauff, Changho Lee, Ling Zou, Claudio Filippone, "Core Design of the Holos-Quad Micro Reactor", proceedings of ANS Winter Meeting, Chicago, Nov (2020). https://www.ans.org/pubs/transactions/article-48894/
2. Nicolas E. Stauff, C. H. Lee, A. Wells, C. Filippone, “Design Optimization of the Holos-Quad Micro-Reactor Concept,” proceedings of PHYSOR, March 29-April 2, 2020. https://www.epj-conferences.org/articles/epjconf/pdf/2021/01/epjconf_physor2020_01005.pdf
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9. Seker, V., Kochunas, B. (2020). Assessment of Local Temperature Reactivity Response in Multi-Module HTGR Special Purpose Reactor. Tech. Report. NURAM-2020-002-00, University of Michigan, Ann Arbor.
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12. Choi, S., Kinast, S., & Kochunas, B. (2020). Point Kinetics Model Development with Predictive Control for Multi-Module HTGR Special Purpose Reactors. NURAM-2020-006-00, University of Michigan, Ann Arbor.
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Lessons Learned

Feedback

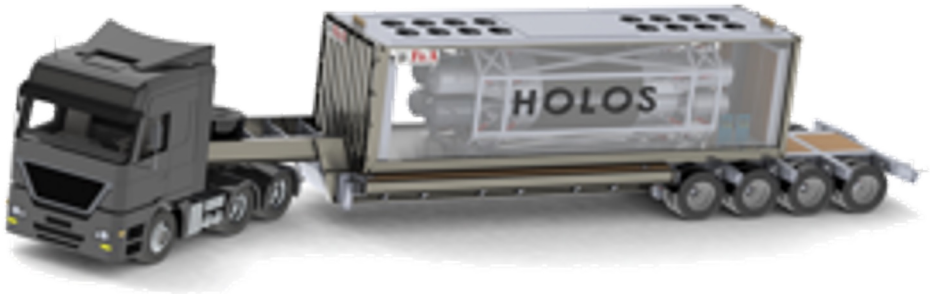
- HolosGen performed under MEITNER from 2018 to 2022
- The ARPA-E MEITNER program enabled HolosGen to validate and de-risk the project
- ARPA-E PDs leadership and skillsets combined with ARPA-E teams enabled completing the project under supply chain disruptions and instabilities caused by COVID 19 pandemic

Feedback

- Expanding access to the Design & Resource Teams structure is beneficial to proposers of innovative non-traditional microreactor designs

Next Steps

- Publications:
  - Gen 2+ ANL Resource Team “Transient Analysis” Report
  - Gen 2+ ANL Resource Team “Thermal-Hydraulic” Report
  - Gen 2+ ANL Design Team “Neutronics” Report
  - Gen 2+ ANL Resource Team “Heat-transfer Analysis” Report



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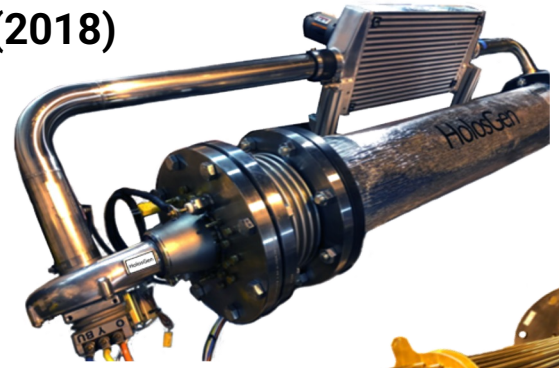
Summary, Q & A

Pre-ARPA-E MEITNER ⟵ ⟶ **ARPA-E MEITNER October 2018 - March 2022**

Conceptual Design (2015)

HTA-1: HolosGen Test Assembly 1 (2018)

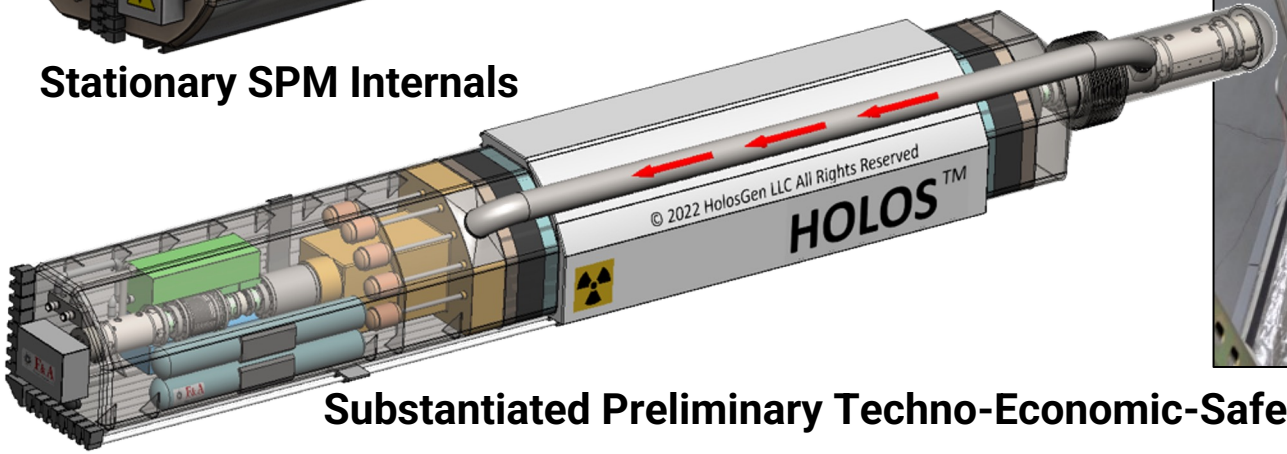


HTA-1
Proof-of-Concept Prototype
(Successfully Tested in Sept 2018)

High-fidelity Modeling & Validation via Subscale Simulator

Coupled Stationary SPMs

Stationary SPM Internals



Substantiated Preliminary Techno-Economic-Safety Performance

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